CLAIMS

1. A lithographic apparatus comprising:

an illumination system configured to provide a beam of radiation;

a support structure configured to hold a patterning device, the patterning device configured to impart the beam with a pattern in its cross-section;

a substrate table configured to hold a substrate;

a projection system configured to project the patterned beam onto a target portion of the substrate;

a liquid supply system configured to provide an immersion liquid between the projection system and the substrate table;

an actuator configured to apply a force to the substrate; and

a compensation controller configured to determine a compensating force to be applied by the actuator to the substrate to be substantially equal in magnitude and substantially opposite in direction to a force applied to the substrate by the liquid supply system.

2. Apparatus according to claim 1, wherein the compensation controller is configured to determine the compensation force in a feed-forward manner.

3. Apparatus according to claim 1, wherein the compensation controller is configured to determine the compensation force in a feedback manner.

4. Apparatus according to claim 1, wherein the compensation controller is configured to determine a compensation force that is filtered and corrected for dynamic properties of the liquid supply system.

5. Apparatus according to claim 1, wherein the compensation controller is configured to determine the compensation force based on an actual or a desired position of the substrate.

6. Apparatus according to claim 1, wherein the compensation controller is configured to control the actuator to apply a compensating force on the substrate table substantially equal in magnitude and substantially opposite in direction to a force applied to the substrate table by the liquid supply system.

7. Apparatus according to claim 1, wherein the compensation controller is configured to determine the compensation force based on a force applied to the substrate by the liquid supply system due to gravity.

8. Apparatus according to claim 1, wherein the liquid supply system comprises a barrier member at least partly surrounding the projection system to define a space between the projection system and the substrate to be at least partially filled with an immersion liquid.

9. Apparatus according to claim 8, wherein the barrier member is at least partly supported by the substrate, the substrate table, or both.

10. Apparatus according to claim 8, comprising a barrier actuator configured to position the barrier member in a direction substantially parallel to the optical axis of the projection system.

11. Apparatus according to claim 10, wherein the barrier actuator is a gas bearing, a hydrodynamic bearing or a hydrostatic bearing.

12. Apparatus according to claim 10, wherein the compensation controller is configured to determine the compensating force based on the force needed by the barrier actuator to keep the barrier member steady.

13. Apparatus according to claim 1, wherein the compensation controller is configured to determine the compensating force based on variations in pressure in the immersion liquid or variations in pressure of liquid or gas in a bearing or seal of the liquid supply system.

14. Apparatus according to claim 13, further comprising a pressure sensor configured to measure the pressure in the immersion liquid, in a seal or in a bearing, a force sensor configured to measure a force between the liquid supply system and the projection system, or both.

15. Apparatus according to claim 1, wherein the actuator is configured to apply force to at least part of the substrate table which supports the substrate.

16. Apparatus according to claim 15, wherein the compensation controller is configured to determine the compensating force based on the desired or actual position of the center of gravity of the part of the substrate table supporting the substrate relative to the projection system.

17. Apparatus according to claim 1, wherein the compensation controller is configured to apply a compensating force on the substrate in a direction substantially parallel to the optical axis of the projection system, and rotationally about axes substantially orthogonal to the optical axis of the projection system.

18. A device manufacturing method comprising:

projecting a patterned beam of radiation through an immersion liquid onto a target portion of a substrate using a projection system; and

determining and applying a compensating force on the substrate substantially equal in magnitude and opposite in direction to force applied to the substrate by a liquid supply system providing the immersion liquid.

19. The method according to claim 18, wherein the compensation force is determined in a feed-forward manner.

20. The method according to claim 18, wherein the compensation force is determined in a feedback manner.

21. The method according to claim 18, wherein the compensation force is determined based on the actual or a desired position of the substrate.

22. The method according to claim 18, wherein the compensation force is determined based on force applied to the substrate by the liquid supply system due to gravity.

23. The method according to claim 18, wherein the compensating force is determined based on variations in pressure in the immersion liquid.

24. The method according to claim 18, wherein the compensating force is determined based on variations in pressure in a seal, bearing or both.

25. The method according to claim 18, wherein the compensating force is determined based on a force needed by an actuator to keep a barrier member steady, the barrier member at least partly defining a space between the projection system and the substrate which is at least partially filled with the immersion liquid.

26. The method according to claim 18, wherein the compensating force is determined based on a force between the liquid supply system and the projection system.

27. The method according to claim 18, wherein the compensating force is determined based on a desired or actual position of the center of gravity of at least part of a substrate table supporting the substrate relative to the projection system.

28. The method according to claim 18, wherein the compensation force is applied on the substrate in a direction substantially parallel to the optical axis of the projection system, and rotationally about axes substantially orthogonal to the optical axis of the projection system.